

HIGH-LEVEL GRAVELS OF THE CAPE AND THE PROBLEM OF THE KARROO GOLD.

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Plates II.-V.

The high-level gravels of South Africa have attracted a good deal of attention for some considerable time owing to the peculiar position they occupy. They are found capping the flat-topped hills all over the southern coast-regions of the Colony—at one time as a flinty quartzite, when they have been mistaken for lava-flows; at another as thick beds of gravel- and boulder-beds perched many hundreds of feet above the present levels of the rivers, when they have been mistaken for the Enon Conglomerate, a member of the Uitenhage Series of Jurassic age.

They were first studied by Mr. Rogers and myself along the seaward face of the great coast-ranges, especially in Caledon, Swellendam, and Riversdale, and later, in the extreme east, in Komgha and Kentani. For some time it was not clear whether the gravels here were old sea-beaches, and that the level flats which they must have originally covered were not surf-cut terraces. As a matter of fact the sea is at the present time cutting ledges along the coast which at low tide are exposed and continue the rocky land-surface for a considerable distance out to sea; east of Cape Agulhas, as far as the Pondoland shore, these surf-cut terraces occur repeatedly, and form the home of the oyster, the octopus, the ollycrock, and other sea delicacies. The gravels, however, have more the appearance of river-borne material, and the fine sands that of river-sand, and the question has been practically settled by the discovery of the fruits of *Chara*—a typical fresh-water weed embedded in the hardened sands in Komgha.

Inland the evidences of the gravels were not so abundant, though Mr. Rogers and myself have recorded them as occurring in Ladismith, Oudtshoorn, and Prince Albert. For the whole of the last year I have been working on the watershed between the Gouritz and Gamtoos river-systems, and have found the high-level gravels

enormously developed, or rather, since they must have existed equally all over the other districts in which small vestiges are still retained, where they have been very little disturbed by denudation.

Seeing these gravels, then, in their full development, I have been able to get a better grasp of their meaning and origin, and I propose in the present paper to work out my views in regard to them. I dare say these will need some modification as our knowledge advances, yet I think a useful purpose will be served in drawing under one head an important body of facts.

Stated briefly, my idea is that at no very distant time there was a plain passing all over the southern part of the continent, and far into the Karroo, which was elevated some 1,000 feet above the level of the present rivers—that is to say, on the coast it was 1,000 feet to 2,000 feet above the present sea-level; in the interior mountainous district, Ladismith, Oudtshoorn, and Baviaan's Kloof, it was 3,000 feet and more, and on the Karroo side of the coast-range it was 3,000 feet to 4,000 feet. This plain was formed when the rivers had reached a quiet stage in their denudation—that is, a period when they no longer cut downwards, but had time to meander backwards and forwards and reduce all the country to a more or less dead flat.

When a river has reached this stage, it is said to have reached its base-level of erosion, and the plain is called a peneplain. It usually occurs when the fall of the river is a very gradual one from a long way inland to its debouchment into the sea. It cannot, however, be said that the present rivers of South Africa have such a gentle fall; in fact, it is the steep gradients that cause all the trouble of the droughts by draining away the water so rapidly; as the plain keeps approximately at the same height above these present river-courses, some other cause than a gradual fall is necessary to explain their existence. The other cause is afforded by the mountain chains which the rivers had to traverse; these produced bars across the river channels, which had to be cut down before the river was free to flow to the sea, and hence behind each mountain chain there was an enforced period of base-levelling, so that the plain, instead of being one continuous slope, is cut into a series of steps. I do not offer this explanation from purely theoretical considerations, but, as we shall see later, there are actually plains now being formed in the Long Kloof from exactly such a cause. The plain-formation, however, must have been aided by a condition in the equilibrium of the land unlike that through which we are now passing, which is one of continuous uplift, so that the rivers are constantly cutting downwards. Before this rise, and may be at the time of the plain-formation, there must have been a great sinking, as the shallow sea-bottom which

extends out to the Agulhas Bank was almost certainly at one time dry land, which has now been covered by the sea, and formed a base-levelled plain at some remote period. The level of a plain need not be all reduced to sea-level in order to produce base-levelling, as a stoppage low down in a river-course, whether from its confluence with the ocean or from a bar in its course, reacts very strongly on the denudation of its upper course; it is as if the river when rapidly flowing was to a certain extent rigid. Good instances of this are afforded by dams across the dry rivers of the Karroo: the water is stopped by the dam-wall, and this reacts all along its course up; floods occur far beyond what one would at first sight think possible for the effect of the dam-wall to reach.

The rocks cut by this bevelling process include all the known rock formations in the west of the Colony, except the Recent; Uitenhage Beds are bevelled equally with the Malmesbury clay-slates, so that the plains were subsequent to the mountain-building and to the Jurassic or Lower Cretaceous rock-formations.

These plains are only plains in the centres of their areas; on one side, or on both, the plain rises to the mountains from which the streams flow (Plate X. 1). Ralph Tarr* has applied to the action of rivers when they cut inclined plains like this the term of "bevelling," and by an extension of the term I shall allude to the intra-mountain plains as double bevels. Of such double bevels there are a number of series between Ladismith and Uitenhage, but the effect of them all was to produce wide-open valleys all longitudinally on about the same level. On the north of this area, in the Karroo, there was a single bevel with a wide peneplain extending some way towards the Nieuweveld and Camdeboo, and on the seaward side there was the single bevel forming the Ruggens of Caledon and Swellendam, and the table-topped hills all along the coast.

As the evidence is best in the double-bevelled region, I will begin my description with that. There are two rivers running westwards towards Oudtshoorn, the Kammanassie and the Oliphant's Rivers. The former has had to excavate its bed through the loose sands and conglomerates of the Uitenhage Series (Fig. 1), while the latter has had to work its way through solid Bokkeveld slates; hence the Oliphant's River has stolen a march on the Kammanassie, and has not only been able to clear its bed and lay down wide alluvial flats, but has captured the head-waters of its rival, so that the Kammanassie River no longer reaches the water-parting between the Gouritz and Gamtoos river-systems. The smaller river, however, is much more interesting, as the stream and its side tributaries has simply

* "The Peneplain," *American Geologist*, xxi., 1898.

cut downwards, leaving the old bevel-surface entire except for the cañon-like gorge through which the rivers run. The farms along the main river are divided into two kinds, one lying on the river-level and utilising the narrow strip of alluvium, the other lying in wide open plains some 800 feet above the other. Communication between the two sets of farms can only be made at a few points, and then the road or footpath is extremely precipitous. Above the plains the mountains rise—on one side, the Long Kloof Mountains, and on the north the Kammanassie. The village of Uniondale lies in the low level along the Kammanassie River, on a place where a tributary from the Long Kloof has by some curious chance been added to its catchment area, and the impact of this new increment of water has washed out a comparatively wide opening in the river valley. East

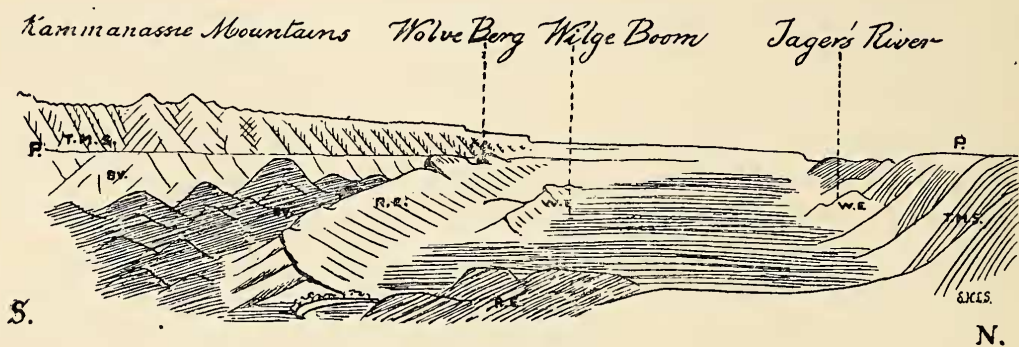


FIG. 1.

P. The High-Level Plateau. **R.E.** Red Enon. **W.E.** White Enon Conglomerate.
BV. Bokkeveld Beds. **T.M.S.** Table Mountain Sandstone.

The Oliphant's River Valley, showing the fold-basin of Enon Conglomerate and the High-Level Plateau or Bevel.

of Uniondale there is the Uitvlugt Berg, which seems a considerable mountain from the village, but on getting out of the gorge of the Kammanassie River on to the plain it loses a good two-thirds of its height; a shelf belonging to the bevel, and covered with fine gravel, skirts the mountain on the south side, while on the north side there is the high plateau itself, only indented by shallow river courses.

At the eastern end of Uitvlugt the river ends blindly in the plateau, and a bunch of finger-like gorges are cut into it. The gravel cap here is very well exposed and is continuous; in the centre of the double bevel it consists of yellow sand some thirty feet thick. The upper portion of the sand becomes intensely hard, due to the deposition of secondary silica between the sand grains; lower down the rock becomes softer, and near the bottom is loose, clayey sand that can be dug with a spade. The quartzite-like surface cracks up

into blocks, which are rounded and become polished by the sand blown over them. The fort protecting the village of Uniondale is built on a very good example of wind-polished surface-quartzite (Plate X. 2). The rock is an exceedingly good building stone: the harder varieties can be used for foundations, bridge work, &c., while the softer are useful for walling; by choosing the particular hardness varieties can be obtained which take mouldings and chisel work. The softer kinds harden on exposure, and once hard are not subject to rotting like the calcareous sands of the coast, as the cementing material here is silica. It is interesting to notice that, with an abundance of the best building stone in the immediate neighbourhood, the architect of the local Dutch Church, in picking the stone for building the tower, took the Table Mountain Sandstone. The rock in its normal condition is all right, but here it is penetrated with shear-planes, along which white mica is developed; the consequence was that before the roof was in place the tower had to be pulled down. In the gravel at the head of the Kammanassie River, beyond Uitvlugt, there are three distinct zones, which seems to point to the fact that after the first layer of gravel was deposited the river became more obstructed, and a higher layer was laid down, and subsequently a third, which facts accord well with the theory that the obstruction was due to the successive sinking of the land surface.

The formation of the steep-sided gorges that commence at their actual heads, with as great a height of wall as lower down, require some explanation. No springs occur in them, and the erosion works backwards as if an invisible steam-shovel were gnawing out the material. Walther, in his monograph on the Deserts, makes out that these cul-de-sacs are peculiar to excessively dry regions subjected now and again to tremendous cloud-bursts. Here, however, we have them forming in a well-watered region, and though it is getting to be a desert from the burning of the mountain veld, it was evidently in former ages very much better watered than now. I think the explanation may be got from studying the drainage system. The Oliphant's River has beheaded the Kammanassie River and left the present head in an aimless way out on the flats. To compensate for this loss, the river has got a large supply of water from the Long Kloof, which runs in at Uniondale, some eight miles down stream from the nominal head; the effective head now lying at the summit of the Prince Alfred's Pass. Directly the main river got this increment, it was once again turned into a powerful chisel of erosion, and rapidly deepened its course. The upper portion, though only containing water after rain, was affected by this lowering of the general level of the main valley, and erosion worked backwards by a kind of

under tow, the bottom of the banks being first attacked, instead of the usual gradual scouring all along the gradient.

The basin of the Kammanassie River is divided from the Long Kloof by a range of hills ; looked at from the head of the pass from Uniondale to Avontuur, the gravel-covered level is seen to be almost continued over the dividing ridge, so that when the gravel was formed erosion of the ridge had practically stopped. Since then, owing to the uplift, the rivers have cut vigorously downwards, but those in the Long Kloof seem to have arrived at such a state of equilibrium that the water was actually stagnant. Near Avontuur, for instance, one area is drained by a stream that has crept in from the Kammanassie River on the north ; another contiguous one has been invaded by a river cutting back from the south, and now drains straight into the ocean by the Keurboom's River, while a third drains eastwards to the Kouga. The Long Kloof is a narrow valley of

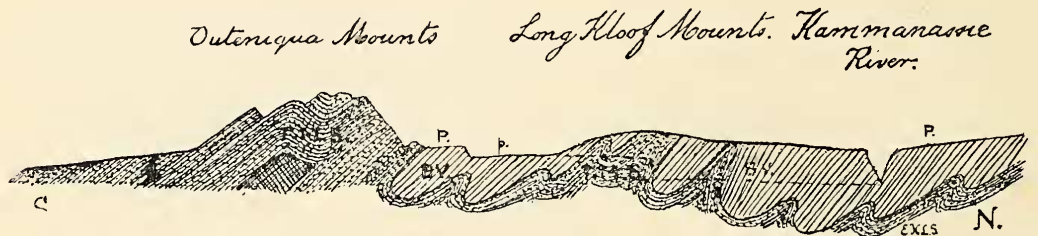


FIG. 2.

Section across the Long Kloof and Kammanassie River valley to show the bevelling (P.P.) and the formation of a lower plain of erosion (p.) due to the obstruction of the stream marked - - - by the Table Mountain Sandstone (T.M.S.) in the Long Kloof Mountains.

Bokkeveld Beds hedged in with hills of Table Mountain Sandstone, and there seems at first sight no reason why one large river should not drain right away down the valley, as is the case with the Oliphant's River in Clanwilliam, which is similarly encompassed. When, however, we find evidence of a former period of no flow—that is, that the whole of the Long Kloof near Uniondale was converted at the time into a swamp—we can understand how it is the side streams from more vigorous river-systems have had time to eat their way back through the dividing ridges, and steal each what it could from this stagnant region. Directly the drainage of the Long Kloof commenced, the plain that had been formed became eaten into by ravines, and when these spread and spread, the plain with its gravel covering became reduced to mere remnants, and hence we see little table-topped hills, gravel-capped, in many places between Avontuur and the George-Oudtshoorn road. Some of these invading streams,

however, took on more than they could satisfactorily accomplish ; for instance, above Commandant's Drift on the Kammanassie, the river of that name has sent a side streamlet that has tapped the Long Kloof east of the farm Molen River (Fig. 2) ; the water pours out over a fine waterfall into a deep pool, and is carried out in furrows ; after the gorge had been first formed, the running water cut down to extremely hard quartzite, which it has only been able to wear away very slowly ; hence the drainage area behind the waterfall has remained at a minimum level for a very long time, and has thus been made into a plain of erosion exactly as the higher plain,

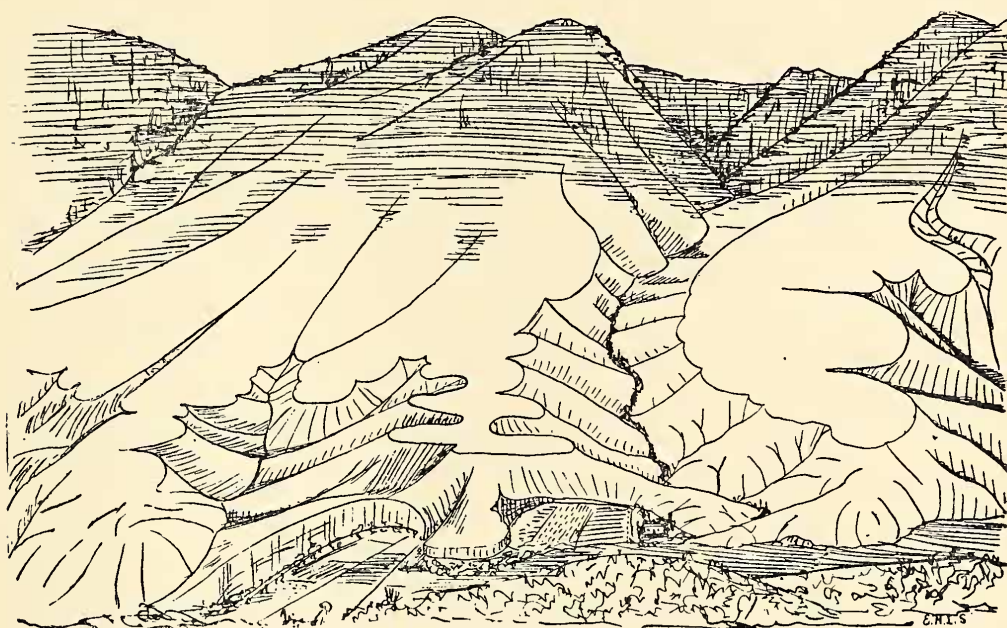


FIG. 3.

Birds'-eye view of the gravel-capped bevel in the Kammanassie Valley opposite Commando Kraal.

of which a few flat-topped hills attest the former existence, was cut down. The Long Kloof, unfortunately, has not yet been geologically surveyed to any great extent, and a good deal more about these river-systems will be learnt when it is done. The gravels in the Kammanassie Valley about Commandant's Drift, and lower down, are coarser than round Uniondale, and are heavily charged with iron (Fig. 3).

In the upper Oliphant's River we have another area where the gravels can be very well seen. Standing on any high point in the rim of the basin one notices a shelf cut in the mountains, which runs uninterruptedly and at exactly the same level all round. It looks as if it were the eroded edge of a lake whose waters had now been

withdrawn, and the occurrences of gravels on the ledge lends additional evidence for this view. But on studying the area further, it will be seen that there are several hills in the centre of the basin which come up just to the level of the ledge and no further, and slowly one gets to recognise that the ledge is but the remnant of a wide high-level plateau which has since been cut into by the natural forces of erosion. Along the south side of the basin, and north of the Kammanassie Mountain, the shelf is still very broad, running out from the mountain a mile or more, and there are only deep and narrow gorges cut into it. The rock out of which the shelves are cut is mostly Bokkeveld Beds. On the north of the basin, however, the width of the shelf is much less, and the end of the remnants facing the main river are not simple mountain slopes covered with débris, but are true dip-slopes of Table Mountain Sandstone. The dip-slopes are very steep, from 45° to 60° , and on some a small patch of Bokkeveld slates is still adherent, and Enon Conglomerate is also to some extent piled against them, but for the most part they are bare rock-faces truncated at the top by the shelf and covered with gravel. We have found these rock-shelves as far west as Seven Weeks' Poort on the Ladismith side; and they can also be very well seen at Meiring's Poort; between these two points there has been so vigorous an erosion that the traces of the old plateau have disappeared, yet it is abundantly evident that the plain did formerly exist here.

At Vlakte Plaats the shelves run together and form a continuous high-level plateau. It is very interesting to notice here the remnants of another plateau only a hundred feet above the present flood-level, and still a third, which only recently has been abandoned by the river, and over which the railway between Jager's River and Uniondale Road is carried for some distance. In this one area, therefore, we have all the stages in the development of the plateaus, each formed during a period of no downward erosion of the river, due to stoppage in its course. The gravel covering the high plateau is in places exceedingly coarse, and the boulders are not rounded; the matrix is yellow clay not usually impregnated with iron, but which becomes flint-hard by the deposition of silica. The lower plateaus are not capped with gravel, but were once probably covered with soil, which has not had an opportunity of hardening, and has consequently been washed or blown away.

At Paarde Kloof there is an isolated hill to the west of the homestead, cut out of white gravel and sand belonging to the Enon Conglomerate, which dip steeply to the south-west; the summit of the hill reaches the level of the plateau, and is covered with the high-

level gravels. The latter consist of the very same pebbles that have been washed out of the Enon Conglomerate, some perhaps from the self-same beds in the upturned edges of which this re-made gravel rests (Plate X., fig. 3). This is an interesting point, as the high-level gravels so resemble in places the conglomerate of the Jurassic or Lower Cretaceous Beds that they can often be confounded, but here we have the most satisfactory demonstration that the high-level gravels are very long subsequent to the Enon Conglomerate.

Nearer the head of the river along the southern flanks of the Anthonie's Berg, the gravel becomes very thick; at the bottom is the normal gravel-capping cemented with iron, then comes a very thick deposit of coarse rubble, 80 to 100 feet thick, and on top of this again white, silica-cemented sand. The actual head of the river lies on the high plateau, and there is a wide area of rolling plains intensely cold in winter, at an elevation of 3,200 to 3,500 feet; it extends towards Willowmore, and forms a connecting bridge of high country between the Anthonie's Berg and the Baviaan's Kloof Mountains. From the head of the Oliphant's River one can look over Nieuwe Kloof and the extraordinary part of the country known as Baviaan's Kloof—both a kloof and a home of baboons *par excellence*.

The geology of Baviaan's Kloof needs a special paper. It is sufficient here to say that there are two great mountain ranges, the Kouga on the north and the Baviaan's Kloof Mountains on the south, rising to 5,000 and 6,000 feet; between them is a wide open plain at the normal elevation of the high plateaus, from 3,000 to 3,500 feet; the distance between the two crests is from nine to twelve miles, and the bevels go very high up the mountain sides, so that practically the whole of the intervening space is the double bevel itself (Fig. 4). In the centre are a number of narrow basins due to the letting down by folding of the Bokkeveld and Table Mountain Beds, and the Enon Conglomerate as well, that at one time lay upon these. To what depth the fold carried the last-mentioned beds we cannot judge, as the bottom of the present valley bottoms are choked with débris, and no borehole or well has been let down far enough to strike rock; the surface of the valleys is from 1,000 to 1,200 feet below the plateau. These little fold- or fault-basins—for the fold is so abrupt that it often passes into a fault—are strung on the Baviaan's Kloof River, like beads on a thread, the river between each basin running through tremendous winding gorges. All over the level country the gravels are strongly developed, and exhibit on the edges of the basins banks of gravel and hardened sand, some 40 to 60 feet thick. The edges are abrupt as

if cut out by denudation, and strongly suggest that at the time of the bevelling the whole of the basins were filled in; an additional evidence of this is that the Enon Conglomerate still left in the little basins occurs on the up-stream end; at the down-stream end it has all been carried away. The krantzies of gravel stand out perfectly vertical on the tops of very steep slopes, and from their nature are easily excavated into small caves and recesses. In these hollows the bees are very fond of building, but the nests are unapproachable; the Bushmen, however, determined to get the honey, used to drive pegs in the vertical face of the rock, and thus made a ladder by

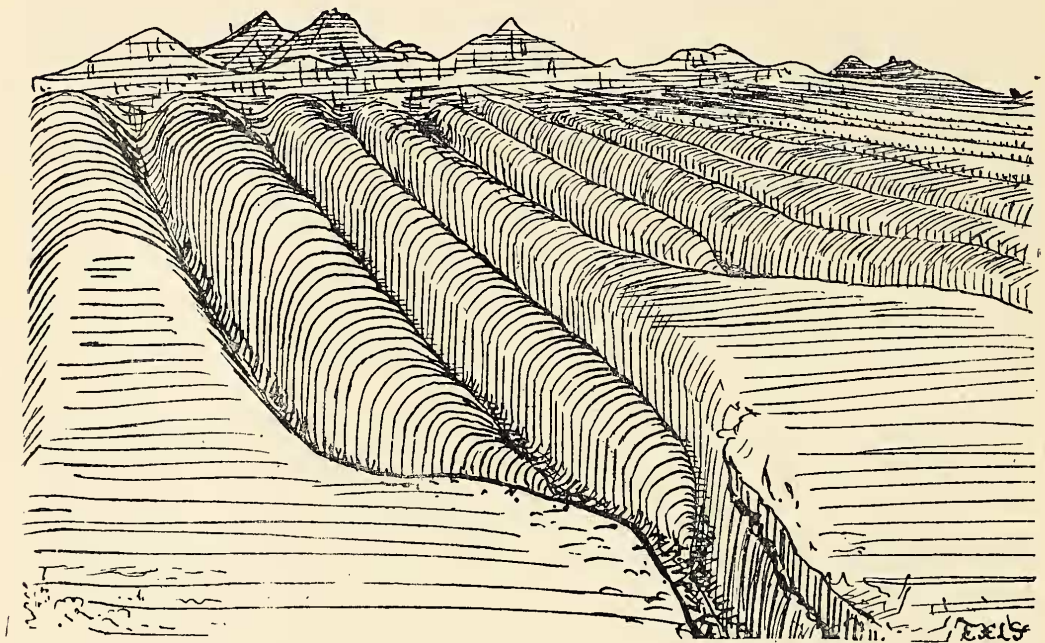


FIG. 4.

View of the Kouga Mountains near Beako's Nek, Baviaan's Kloof, showing the original bevel deeply incised by the stream-beds. The rock is Table Mountain Sandstone with vertical dip.

which to reach the nest; the pegs can still be seen in many places in Baviaan's Kloof, especially by Verloren River.

Turning now to the gravel-covered bevels north of the inner coast range, the Zwartebergen, we find but a few isolated patches of the gravel cap left. Near Floris Kraal, by Laingsberg, at Prince Albert village on the east, and near Klaarstroom on the Prince Albert road, there are unmistakable gravel plateaus, but whether these belong to the great system that we have been discussing in the inter-mountainous region is another thing. I believe the tops of the Witteberg hills here represent that period, and that the gravel caps just mentioned, except perhaps the Floris Kraal one, are on a lower level

—that is, belong to a later level of erosion. It is an extraordinary thing, that throughout the Witteberg hills which lie to the north of the Zwartebergen and are continued towards Grahamstown, the tops are all ground flat to a level from 3,500 to 4,000 feet above the sea, and this in spite of the fact that the strata of which they are composed are contorted into the most abrupt and intricate folds. On the inside of the Cederbergen we get the same Witteberg hills, but the strata there are lying almost flat, and the phenomenon of their being flat-topped did not therefore excite any particular attention when they were surveyed, but in spite of the horizontality of the component beds I now believe the actual summits of the hills are due to a base-levelling similar to that which has reduced the folded region to the east of them. Points on these hills do certainly rise so high that one cannot include them with the peneplain; for instance, the hill to the north of Willowmore called Aasvogel Berg, is 4,400 feet, but this, I take it, is either a portion that has escaped the levelling, forming, as it were, an island, or has since been raised by earth movements, either explanation being equally probable. To the east of Aasvogel Berg, however, the hills are cut strictly to a plateau which has now been worn into, and the softer beds removed, so that the country is one succession of steep valleys; yet the crests of the intervening ridges all touch a level sky-line, and occasionally also open flats still occur perched on top of the hills. These latter are very important economically, as the Witteberg rocks are not as a rule pervious to water, and the highly inclined beds of quartzite act like so many pent roofs, down the sides of which the rain-water rushes so impetuously that none is left to sink into the ground and nourish the vegetation that grows upon them; where these flats occur, since they include the softer rocks as well as the harder quartzites, the rain-water has a chance to sink in, and, as a result, they are covered with grass and luxuriant bush, and below them springs issue.

When one looks northwards from these hills in the region of Prince Albert, one notices an immense plain and then a ridge of hills; one can see the two very well from the railway between Prince Albert Road and Groot Fontein on the Western system. One at once notices that these hills to the north of the plain are all level-topped, or at any rate the summits of the ridges all rise to a certain elevation, no more and seldom less; this unmistakably indicates that they are remnants of a plain of erosion, as the beds of which they are composed are contorted, and had they not been so cut down they would have formed a series of jagged and irregular hills (Fig. 5). The height of the hills is from 3,000 to 3,500 feet, and

the plateau of which they are part must have at one time been very extensive. The Witteberg hills by Prince Albert, rising to 3,500 to 4,000 feet, are also part of a plain which at one time was very extensive, and thus it is almost certain that the two plains were at one time continuous, and that what remains of them now has been separated by the rivers, of which such mighty chisels of erosion exist in the Gamka or Lion River and the Dwyka. These northerly hills only extend as far as the Prince Albert Division; eastwards, beyond, we get the immense plains of the flat Karroo, the Beaufort, Aberdeen, Willowmore, and Graaff-Reinet flats, in which the rivers have an immense thickness of Witteberg quartzite to traverse, and have to do so along their strike, which is always the least susceptible to river erosion; the rivers, therefore, are to a certain extent dammed back and have cut out a plain exactly as I have supposed them to have done on a higher level in

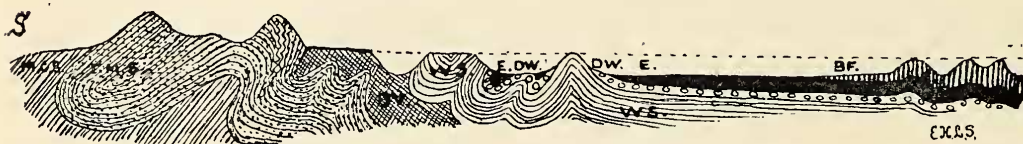


FIG. 5.

M.C.S. Malmesbury Beds. **T.M.S.** Table Mountain Series. **BV.** Bokkeveld Beds. **WS.** Witteberg Beds. **DW.** Dwyka Beds. **E.** Ecca Beds. **BF.** Beaufort Beds.

Generalised Section from the Zwartbergen to the Prince Albert Goldfields, showing the old High-Level Plateau which has now nearly disappeared.

bygone days. Should a channel be cut through the Witteberg hills, by which a shorter passage could be obtained for the flood-water from these plains of the Flat Karroo to reach the ocean, there is little doubt but that the plain formation would be broken up, and a Rugte veld or Kopjes veld produced, as in the hills north of Prince Albert.

It is in these northerly hills that the gold has been found in the Prince Albert Division on the farms Spreeuw Fontein, Klein Water-val, and north of Commando Kraal. The gold has always been alluvial, for the most part being found in the mud and dirt extracted between the joints of the sandstones. Prospecting has everywhere been vigorously prosecuted, but up to the present no signs of any reef has been discovered. I have known these fields for ten years, and have always been very sceptical as to whether any gold-bearing reef will ever be found in this part of the Karroo; there are abundant quartz reefs, some pure, solid, white quartz, others locular, and

made up of small transparent yellowish crystals of quartz; these reefs fill cracks which have been caused by the contraction of this part of the earth's surface, probably due to the contraction after the heating produced by the injection of the dolerite sheets and dykes. The quartz has been deposited from water, and it is very improbable to my mind that the cracks can have penetrated sufficiently deep to allow the metalliferous solutions that came from the earth's interior to reach them. It is not, of course, impossible, for we know of springs in Nevada to-day that bring gold in solution to the surface, but in these comparatively recent rocks as those of the Karroo, that do not date back beyond the Permian or Trias, one does not look for metal-bearing reefs. The same opinion was expressed by Mr. Sawyer in his report on these fields. How, then, did the gold get to the Prince Albert gold-fields?

As a result of my recent survey I am very strongly of opinion that the gold came from the Zwartebergen, and was carried over to the various localities where it is now found, on top of the old high-level plateau. The evidence is satisfactory as far as I can make out, for the gold is found all along the belt of high country and nowhere else. If hearsay evidence can be admitted, it also points that way, for I heard stories that gold had been found recently on the top of the Witteberg hills at Zoetendal's Vley, and Mr. T. Bain records a find of gold near the same place in 1891. I heard similar stories that gold has been found in fallen blocks on the flanks of the Zwartebergen themselves, at Scotch Kloof on the farm Damascus. I state these facts simply as I heard them, and I had no means of sifting them to learn what amount of truth there was in them; when any one finds gold, he keeps the fact as secret as possible and certainly will not give any information to a Government official. Whether these finds have been gold or no, they occur in places where they very well might be, and the Zwartebergen do undoubtedly contain gold in small quantities, and it is quite possible that deposits may be found in them as rich as those in the Outeniqua Mountains in Knysna, which are in the same formation. Further, there exist in the Zwartebergen beds of true banket, which are no more than old gravels, and may, of course, be barren; but it is a significant fact that the Knysna gold is found in the immediate neighbourhood of similar beds of banket (Plate X. 4).

For a reason that is not yet sufficiently explained, where there is a deposit of sand and gravel, if there are any heavy metallic particles borne by the stream by which they are being deposited, it is always in the gravels that the metallic particles are deposited. On the Rhine and on the Irawadi River in India the sands are perfectly

free of any trace of gold, yet the gravels contain appreciable quantities, and such deposits have been worked from time immemorial; in a sandstone formation one, therefore, always looks to a banket or conglomerate bed as the one most likely to contain the precious metal.

The whole problem of the Karroo gold amounts to this: it is unlikely that reef gold occurs in the Karroo, while it certainly exists in the Table Mountain Sandstone of the Zwartebergen; by the knowledge that the localities where the gold is now obtained were once connected by a graded plain cut by rivers flowing north from the Zwartebergen, we have an adequate explanation of how the gold was carried from the one place to the other. There are no gravel caps to the hills on the Karroo gold-fields, and all signs of the flat ground have disappeared, but once the gold got to the place and the levelled hills became cut into the kopjes as they now are, the gold on top would sink with the sinking of the valleys, and instead of being carried off with the lighter sand, would be left behind and come to rest in the crevices of the rock, just as in actual sluice-boxes the gold grains come to rest in the furrows of the shoots.

The problem of the high-level gravels is one of altitude, and there are too few bench marks in the Colony to make any reasoning of the above sort perfectly satisfactory. I have throughout had to use rough estimates and calculations from bench marks up along assumed rates of increase in the falls of the rivers. It would be of very great value not only from a theoretical standpoint, but also from a practical one as well, if three or four carefully levelled sections were run from the coast inland; not only would we be able to discuss such apparently trivial things as the existence in past ages of old land surfaces, but one could gather from such sections a true idea of the present fall of rivers, and once that was obtained, we should no longer be in doubt about the various irrigation schemes that are continually being proposed—we should have solid data on which to base our estimates.

APPENDIX.

A SHORT HISTORY OF THE PRINCE ALBERT
GOLD-FIELDS.

The first nugget that was found on the Prince Albert Gold-fields was obtained on the farm Spreeuw Fontein, by Mr. Lodewyk Botma, from the dirt thrown out by an Aard vaark (ant-eater) that was making a hole. The nugget weighed $2\frac{1}{2}$ oz., and was rounded and water-worn, but had all the same a few crystals of quartz adherent. This was in 1871. The same year Messrs. Barry and Nephews, of Port Beaufort, employed Mr. E. J. Dunn to go and report on the find, but the result was an adverse opinion. So the matter rested till 1891, when a shepherd picked up another nugget on the adjoining farm Klein Waterval, weighing 6 dwt. 23 grns. Soon afterwards, or to be precise, on the 4th August, 1891, the farm Spreeuw Fontein (19050 morgen) was thrown open to the public, and on the 20th September the farm Klein Waterval (3898 morgen) was added to the public diggings. At the opening some 500 persons were present, and before the end of the year 1,042 claims had been registered and 504 oz. of gold obtained. The largest quantity obtained by one man was 100 oz., and this was on the claims belonging to Mr. P. H. du Plessis, the original prospector. Mr. Botma, the owner of Spreeuw Fontein, laid out a township which he proposed to name Gat's Plaats, I suppose in memory of the Aard vaark's hole. Interest gradually waned, and when I was there in 1895 working had fallen into the hands of a few poor coloured men; at last, in 1896, even the Registrar of Claims was withdrawn. Various attempts have been made to reawaken interest in the fields, and during the war there was a report of a new find of a large nugget, but all to no purpose. For some years now a small syndicate at Prince Albert has kept a prospector at work to the east of Spreeuw Fontein, on the Willowmore border, but the results of his work have not been made public.

REFERENCES TO REPORTS ON THE GOLD-FIELDS.

- A. 29-71. Report on the indication of the existence of gold in certain of the Western Divisions of the Colony, by E. J. Dunn.
- A. 30-71. Report on a tour made by Dr. W. G. Atherstone and Mr. Thos. Bain in connection with the gold discovery in the Gouph.
- A. 12-91. Report of the Geological and Irrigation Surveyor (T. Bain) upon his recent investigation into the gold discoveries on the farms Spreeuw Fontein and Klein Waterval, with annexure by Mr. H. M. Oakley.
- A. 13-91. Report upon the discovery of gold in the Division of Prince Albert by T. Bain.
- G. 28-92. Report of the Inspector and Registrar of Mines, Prince Albert (H. M. Oakley), for the year 1891.
- G. 45-93. Report upon the Geology and Mineral Resources of the Division of Prince Albert, A. R. Sawyer.

EXPLANATION OF PLATES.

PLATE II.

South end of Meiring's Poort, east side. The bevel is shown cut in Cango Beds and Table Mountain Sandstone; it is seen rising rapidly towards the mountains on the left, the Zwartebergen, and in part is covered with coarse gravel. An enlarged portion of the gravel is shown in fig. 1, Plate III.

PLATE III.

Looking eastwards from the fort on the south of the village of Uniondale. The valley and head of the Kammanassie River is seen below, and the Oude Post Berg on the extreme left. In the foreground is the irregular surface of the high-level river-deposit, here consisting of sand, hardened by deposition of silica till it is a compact mass of yellow quartzite; the rounded surfaces of the weathered blocks are wind- and sand-polished. In the distance the high-level plateau is well shown, and there is an isolated flat-topped hill in the centre, similar to that from which the photograph was taken.

PLATE IV.

Fig. 1.—The coarse gravel capping the bevel terrace on the south end of Meiring's Poort, east side; it is seen from a distance in Plate I.

Fig. 2.—Roode Kop, Paarde Kloof, Uniondale. Recent gravel is shown resting on the upturned edges of Enon Conglomerate (Lower Cretaceous or Jurassic Beds).

PLATE V.

A bed of banket in the Table Mountain Sandstone, Jager's River, Uniondale.